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A DISCOVERY OF HORIZONTAL CURVES IN THE ROMAN TEMPLE CALLED "MAISON CARRÉE" AT NIMES.

(PLATES I, II.)

The purpose of this paper is to call attention to an important observation made in February, 1891, on the fine and well-preserved Roman temple at Nimes called the "Maison Carrée"—viz., that it is constructed with the optical refinement of the curved horizontal lines hitherto considered peculiar to the Parthenon and other Greek temples of the fifth or sixth centuries B. C. This is the first observation of the horizontal curves in a building wholly Roman and proves their continuance to a date three or four centuries later than was previously known.[1] This observation also antagonizes the current presumption of archæologists that the imperial period was indifferent to this refinement or incapable of achieving it.

Herewith is the attestation of the present official architect of the city of Nimes, together with that of his predecessor in office, both of whom have been very helpful to me in the matter of measurements and friendly sympathy. These gentlemen had not previously noticed the curves; for the reason, as I believe, that they

[1] The small remaining portion of the architrave of the temple of Olympian Zeus at Athens shows the curve. This architrave is supposed by Penrose to date from Antiochus IV. (174 B. C.) The curved foundations date from Peisistratos. Opinions as to the date of the *Maison Carrée* vary between the first and second centuries A. D.

produce a perspective illusion as to the size of the building and hence present themselves to the eye as a natural effect, according to the principles of curvilinear perspective. Measurements such as are usually taken in surveying a building do not indicate the existence of a curve in the horizontals, because the width or height is estimated in such surveys by a single measurement or at best by two; taken at the extremities. At all events it is in point to observe that although measurements of the Parthenon were undertaken by Stuart and Revett about 1756, it was not till 1837 that the horizontal curves were seen and announced by Pennethorne and not till 1846 that they were measured by Penrose. There is an archæologist of distinction resident at Nimes, M. Aurès, who is thoroughly familiar with the observations of Pennethorne and Penrose and who has published measurements of the *Maison Carrée*. His measurements were devoted, however, to questions of ancient methods of metrology. They were taken for him by another person and do not, as published, include the curves. M. Aurès, who treated me with great courtesy, is of advanced age and so infirm that he was unable to examine the building with me. The following attestations from the architects Augière and Chambaud are therefore important.

I. "*Les mesures ci près*[2] *ont été prises avec l'assistance de M. Augière, architecte de la ville de Nimes. Il constate avoir observé les courbes avec M. Goodyear, et il constate qu'il n'y a pas eu poussée dans la corniche du côté Ouest.*[3] *Étant professeur de perspective M. Augière veut dire qu'il considère la théorie de M. Goodyear, sur l'effet perspective d'une ligne convexe en plan, nouvelle mais raisonnable. Quant à l'effet d'une ligne concave en plan à certains points de vue, c'est chose connue des professeurs de perspective.*"

(*Signed*), AUGUSTE AUGIÈRE.

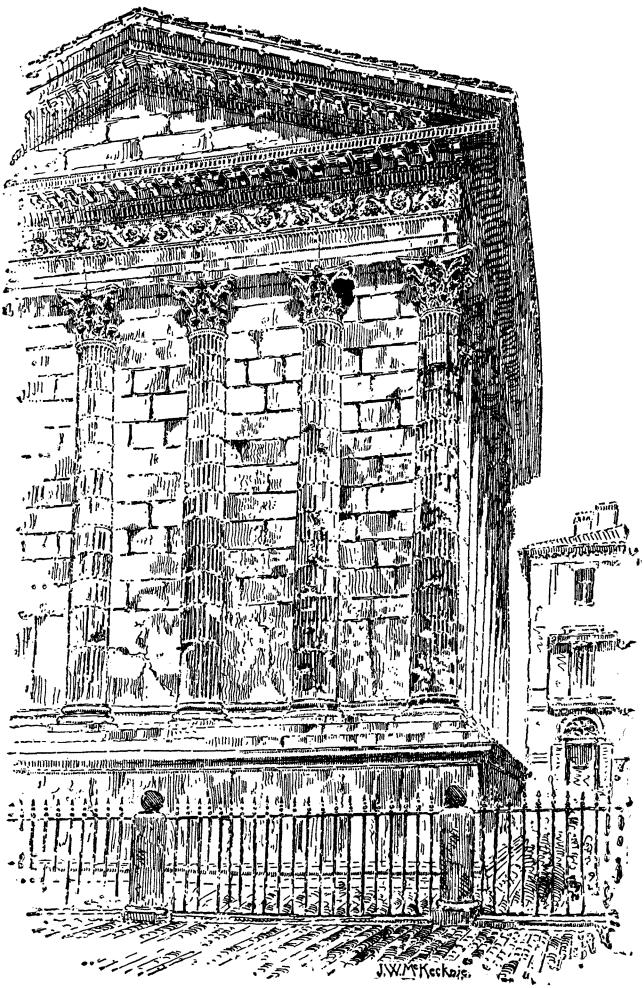
Architecte-Directeur des travaux publics de la ville de Nimes, Professeur d'Architecture et de Perspective à l'École des Beaux Arts. Feb. 20th, 1891.

The second letter is as follows:

[2] This matter is written on the leaf of the note book containing the original measurements.

[3] It was on this side that the observations for the cornice were taken as the curve is exaggerated on the East side by a movement in the masonry.

II. "*Le soussigné, Eugène Chambaud, Architecte de la ville de Nimes en retraite, après avoir examiné avec M. Goodyear, les lignes courbes de la Maison Carrée, a constaté l'existence de ces lignes, comme étant dans la dite construction ; toutefois avec la réserve que la courbe de la corniche*



REAR OF MAISON CARRÉE AT NIMES.
Drawn from a photograph to show the cornice curve.

du côté Est a été exagérée par une poussée de la toiture, mais aussi en constatant le fait qu'il y a courbe aussi de ce côté dans la construction originale, en vue du fait que la ligne des bases des colonnes est courbe de ce côté, comme sur les autres, et qu'il n'y a pas poussée dans la ligne

des bases ; en vue aussi que la poussée est loin d'être assez grande pour avoir produit la courbe de la corniche. Il estime que les théories de M. Goodyear, sur l'effet perspectif des courbes, sont raisonnables, et il remarque que la théorie sur l'effet de perspective d'une courbe convexe en plan est nouvelle mais possible. Il a remarqué avec lui que les variations dans les distances entre les colonnes sur quatre côtés du monument auraient sans doute un effet de perspective selon les idées de M. Goodyear. Les joints de la corniche du côté de l' Ouest ou il y a courbe de onze centimètres et demi, mesure de M. Goodyear, sont parfaits avec une seule exception qui n'est pas importante pour la question de la courbe.

Nimes, le 23 Février, 1891.

E. CHAMBAUD."

The curves which are thus attested to exist in the masonry construction and to have been measured with official concurrence and assistance are convex curves in the exterior plan of the cornice on both long sides of the building of about five inches deviation from a straight line at their centre. The curves are partly produced by leaning out the walls and engaged columns at and near the centres of the sides. Part of the curves may be obtained by a gradually projected arrangement of the blocks of the cornice itself, but the cutting of its profiles and dentils is too rich and complicated to allow of a definite observation on this point, as long as the masonry above is concealed by the modern roof and gutter. Slight curves convex to the line of vision may also be observed in the walls and engaged columns of the temple at the level of the stylobate. Although the decorative carving of the temple, frieze, cornice and capitals is extremely rich, the masonry will not compare with that of the Parthenon or other Greek temples for refinement of quality or construction. The curves, and the masonry arrangements by which they are produced, correspond to what one might expect from the general distinctions between the art of the Empire and that of the V century B. C. in Greece. However, although the masonry is coarse and careless as compared with the Parthenon, there can be no doubt that the joints of the cornice masonry show close fitting and that they are without any of the breaks on the East side which a movement of masonry due to bulging from accidental causes would necessarily exhibit. One piece of the cornice on the West side, that nearest

the South corner, has slipped downward and has weathered badly at the exposed surface, but the joint has not parted even here. The curve of the East side cornice appears to be nearly double that of five inches which I measured on the West side, but as the joints have parted here, I took the advice of M. Chambaud not to measure this curve.

One result of this extraordinary deflection in construction—extraordinary, that is, in its amount, from the standpoint of the Parthenon curves (which are more than doubled here for the given length),—is to give a pronounced effect of a rising curve in elevation to the entablature and cornice of the long sides. As seen at an angle of forty-five degrees a curve convex in plan will produce the effect of an equal curve in elevation—so I am advised by experts in perspective. Thus the observer standing near the centre of one of the long sides of the *Maison Carrée* and looking at the cornice at an angle of forty-five degrees has the effect of a curve in elevation double that of the long sides of the Parthenon for the given length and about three times as great as the curves of the Parthenon at the ends of that building, which correspond approximately to the length of the long sides of the *Maison Carrée*. The eye would naturally discount this effect as being one of perspective and it is quite certain, whatever may have been the purpose of the curves, that this apparent increase of dimension is one of their results for all eyes. Even when the curve is noticed the optical illusion is the same, for it is absolutely impossible for the eye to detect the curve as being anything but the optical curve of a line seen in perspective when facing the sides of the building. It is only by sighting near the angles that the curve is seen to be in the masonry.

It was this appearance of a rising curve in elevation, as seen in a photograph of the *Maison Carrée* in New York in 1879, which led me since that time to believe that the Greek curves would be found in the *Maison Carrée*, and my visit to Nimes was consequently made for the purpose of verifying this suspicion. The fact that Nimes was settled by a colony of Alexandrian Greeks, gave an additional stimulus to my anticipations. It has always appeared to me improbable that the use of the Greek curves should have been unknown to the Roman imperial period,

seeing that our only authority regarding them in ancient literature is a Roman who recommended their use; and seeing, also, that it was the prescription of Vitruvius which first suggested to Pennethorne that the curves might be found in the Parthenon.[4]

My observations at Nimes agitate once more the still undetermined question as to the purpose of the Greek curves in general. The explanation offered by Penrose[5] starts from the tendency to an optical downward deflection ("alveolation") in the straight cornice line of the pediment, and supposes the rising curve of this line to have had the purpose of counteracting this optical deflection; but in the *Maison Carrée* nothing has been done to counteract this "alveolation" which is very apparent in this building for the pediments; so much so that it appeared to me that this downward curve has even been exaggerated by the masonry construction. It has been made probable by Thiersch[6] that there is an "alveolation," or optical downward deflection, in the stylobate lines of a Greek temple as seen from below near the angles, and he supposes that the rising curves of the temple flanks were intended to correct this effect; but it is impossible that a bulging curve of five inches deflection was constructed in the *Maison Carrée* with reference to an "alveolation" of the side lines. Two considerations are conclusive on this head: (a) The "alveolation" was left without correction in the straight lines of the pediments, where it is naturally much more pronounced. (b) Thiersch does not claim an "alveolation" for the side lines except as seen near the angles, and here the bulging curve of the *Maison Carrée* could not produce the optical correction.

The German architect Hoffer, whose observations of the horizontal curves of the Parthenon were contemporaneous with those of Pennethorne, believed the curves to have had the purpose of increasing the apparent size of the building according to the principles of curvilinear perspective.[7] This suggestion was re-

[4] The existence of the curves in the ancient monuments appeared so improbable to the architect, Wilkins, who published a translation of Vitruvius in 1812, that he added a foot-note to the passage on the curves, intimating that such a refinement probably never existed in actual practice.

[5] *Principles of Athenian Architecture.*

[6] *Optische Täuschungen auf dem Gebiete des Architectur.*

[7] *Wiener Bauzeitung*, 1838.

vived by Boutmy[8] in 1870. Both these students confined their explanations to a point of view assumed to be nearly opposite the centres of the building and at some little distance from it, and I think it has not been observed that a line or surface, concave to the standpoint of vision, may produce a perspective illusion from every standpoint of vision to which it is concave. According to the teachings of perspective experts, a deflection or curve in a line or surface supposed to be straight concave to the line of sight, throws the extremity of that line, by an optical illusion, to the point which that extremity would occupy in a straight line of greater length. It follows from this that a curving line not obtrusive to the eye may produce a perspective illusion from every standpoint of vision to which it is concave. The proposition that a line or surface with curve convex to the line of vision may produce a perspective illusion for every standpoint to which it is convex, can be demonstrated without mathematics. I was tempted to submit it to the architects of Nimes above mentioned, and it now has the ratification of a professor of perspective. The proposition is probably novel. Should it meet wider acceptance it would not prove that the curves of the *Maison Carrée* had, among other possible purposes, a perspective intent; but it would prove that they have a perspective effect as result, and would consequently explain why they have so far escaped notice. The proposition may be stated for lines or surfaces convex to the line of vision and having apparently or approximately equidistant divisions, as follows: For every such line or surface assumed by the eye to be straight; given a point of view not opposite the centre of the line, the spaces nearest the eye are unduly widened and the spaces farther from the eye are unduly foreshortened—hence a perspective illusion. For every such line or surface assumed by the eye to be straight; given a point of view opposite the centre division, all other divisions are unduly foreshortened, and the centre division, which has increased width, as being nearer the eye, gives the norm of computation—hence a perspective illusion. The proposition is, therefore, that all architectural curves, in lines presumably or apparently straight, may produce a perspective illusion from whatever point viewed. In 1886 this

[8] *Philosophie de l'architecture en Grèce.*

proposition, in this shape, was verbally laid before a distinguished American architect and perspective expert, and was not received with disfavor. The most important effect of a curve convex to the line of vision in the upper line of a building is, however, without doubt, its tendency to exaggerate the ordinary appearances of curvilinear perspective, in this upper line, especially on near approach to the building. At points inside the angle of forty-five degrees the apparent elevation of that part of the cornice nearest the spectator is enormously increased, and the perspective effect of the descending lines, as seen on either side in perspective, is therefore enormously exaggerated. Plates I and II illustrate this effect in bird's-eye view. It is so much greater than the other effect I have suggested for a convex curve that the former seems hardly worth debating—unless we conceive that even the most delicate changes of appearance in dimension involve an optical mystification which was one result sought.

I should be sorry to damage the effect of a positive and matter of fact observation of great importance to archæologists by the introduction of theoretical matter, but the existence of a temple with curves confined to those convex in plan is undoubtedly outside the limit of explanations hitherto offered for the Greek curves. Moreover there must be a reason why a rather obvious phenomenon has hitherto escaped notice in a temple as well known as the *Maison Carrée.* No doubt the first impulse of any modern builder, architect or expert is to attribute deflections in the masonry of an ancient building to movements in the masonry due to accidental causes after construction and this cause of oversight must also be considered.

The intercolumnar spacings on the West flank of the *Maison Carrée* are as follows, measured from South to North in feet and inches—4, 2 : 4, 3 : 4, 3½ : 4, 3½ : 4, 4¼ : 4, 5 : 4, 3½ : 4, 3 : 4, 3 : 4, 4½. The intercolumnar spacings on the East flank, measured from South to North, are as follows—4, 6 : 4, 6 : 4, 3 : 4, 4¾ : 4, 3 : 4, 5½ : 4, 1½ : 4, 1 : 4, 3½ : 4, 4. The intercolumnar spacings at the Façade (North) end of the temple are, as measured from East to West—4, 1½ : 4, ½ : 4, 3 : 4, 1 : 4½. At the South end measured from East to West these spacings are—4; 4, 1; 4, 3¼; 4, 1; 4, 3.

The greatest variation in the intercolumniations of the Parthenon is about an inch and a half. Between the highest and lowest measurements here we obtain a variation of five inches. There does not appear to be any scheme in the Parthenon intercolumniations excepting that of optical mystification and it may be that these variations have no other purpose. The only scheme to which we find no exception in the *Maison Carrée* is that the central intercolumniations of each flank and of each end are wider than the spaces adjacent. Boutmy has announced a perspective scheme in the spacing of the metopes of the Parthenon which have a maximum variation of over three inches in favor of the central spacings, as against those of the angles.

My measurements at Nimes were much assisted by introductions from Professor Reginald Stuart Poole, who was acquainted in advance with the anticipated results of my visit. M. Henri Révoil, Architect of Historic Monuments, allowed me to place ladders against the building, and M. Augière deputed several workmen from the municipal employés and one of his assistants to help me. The *Maison Carrée* is, however, including the elevation of the stylobate, as high as the Parthenon, and it was found necessary to employ workmen accustomed to repairing roofs. These scaled the building by knotted ropes hung from the roof, and after securing themselves beside the cornice by iron hooks and a body belt, were able to determine the curve of the cornice by dropping a plumb-line from three different points (the angles and centre) to the stylobate below. The points thus fixed were marked and the amount of deflection was then established by a surveyor's line. M. Chambaud has a very exact knowledge of the roof and cornice masonry of the temple, having personally inspected the joints of the cornice during repairs which he made on the roof, and his verdict on the questions of cornice masonry must be regarded as final.

II.

There is said to have been a colony of Alexandrian Greeks settled at Nimes,[9] and the influences of Greek art and Greek race are generally recognized for Southern France. This may

[9] There is ancient authority for this statement, but I have lost my reference.

be an explanation of the survival of the Greek refinement of horizontal curves at this particular point. Inasmuch as the Greek curves are generally known as having been curves in elevation (not in plan), the existence of curves convex in plan on the long sides of the Poseidon temple at Pæstum is a fact to be emphasized. Penrose supposes that curves at Pæstum are confined to the pediments at the ends of the temple (curves in elevation), but Jacob Burckhardt attests the existence of convex cornice curves in plan on the long sides of the temple, and as being in the masonry construction and not owing to displacement.[10] This observation by Burckhardt is noted by Thiersch. The latter assumes, without proof, an accidental cause. Burckhardt confines his explanation to the point that the curved line has more beauty than the line which is mathematically straight, and that an effect of life and grace is obtained by its use. Since we now have at least two cases of classic temples showing curves in plan on the cornice line, as distinct from curves in elevation, it seems wise to publish observations which I have made for curves in plan, convex to the line of vision, in the temple courts at Karnak, Luxor, and Edfou. Mr. John Pennethorne, who discovered the curves of the Parthenon in 1837, had discovered two years earlier (1835) convex curves in plan in the cornices of the second court at Medinet Habou; but this observation was not published until 1878, and seems to have been utterly overlooked since that date by all Egyptologists. These curves have eight inches deflection on the short side of the court and four inches deflection on its long side. They are an excellent illustration of the optical illusion which results from a curve convex to the line of vision. It was impossible for me when standing in the court to distinguish these lines from the curves of perspective. Every person who has been in the second court at Medinet Habou, without noticing these curves, must have discounted their effect into an appearance of greater length in the sides of the court; and it should be borne in view that a knowledge of the existence of these masonry curves is not the slightest detriment to the optical illusion. It is only on the roofs of the porticoes and by sighting from the angles that the curves are detected as independent of optical effect. It may be added

[10] *Der Cicerone*, vol. I, p. 5.

that Egyptologists are generally agreed in attributing a purpose of perspective illusion to the arrangement of apartments in certain Egyptian temples, as regards the gradual descent in height of apartments, the gradual ascent in line of pavement, and the gradual narrowing in of apartments in the direction away from the entrance. This is mentioned, for instance, by Professor Maspéro, also by Professors Reginald Stuart Poole and Rawlinson.

My own observations in Egypt supplementary to those of Mr. Pennethorne, may now be noticed. At Edfou I observed curves of plan in the cornices of the great court convex to the line of vision. I measured the curve on the roof of the East side of the court and found that it amounted to ten inches. I believe the length of the side is 140 feet. This cornice has moved forward undoubtedly, as shown by a parting of its joints and by the parting of joints on the inside faces of the columns supporting it, but I measured curves on each of the four sides of the court *at the level of the pavement*, all convex to the centre of the court, each with a deflection of one and a half inches. From the construction of the courts at Medinet Habou and at Edfou, it is clear that the curves were obtained in the Egyptian cornice by a gradual leaning forward of the columns of a court, the lean to the front increasing as the columns approach the centre. At Medinet Habou, for instance, the curve in the line of columns near the bases is not perceptible to the eye when sighting for it, although the maximum of curvature in cornices is eight inches and instantly detected by sighting on the level of the roof. This method of construction would explain the displacement of the cornice at Edfou, which has exaggerated the curves, for all earthquakes and other forces tending to disintegrate the masonry would tend to weaken the building in the direction to which the columns were already leaned.

I found curves in the lines of the columns at Luxor in every court, and in each case convex to the centre of the court. These curves measured from one and a half inches to seven inches deflection. The central columns on two sides of the rear court at Luxor are shored up by beams since the excavation, finished in 1891, and would otherwise fall forward into the court. This movement of the columns is to be explained by an original con-

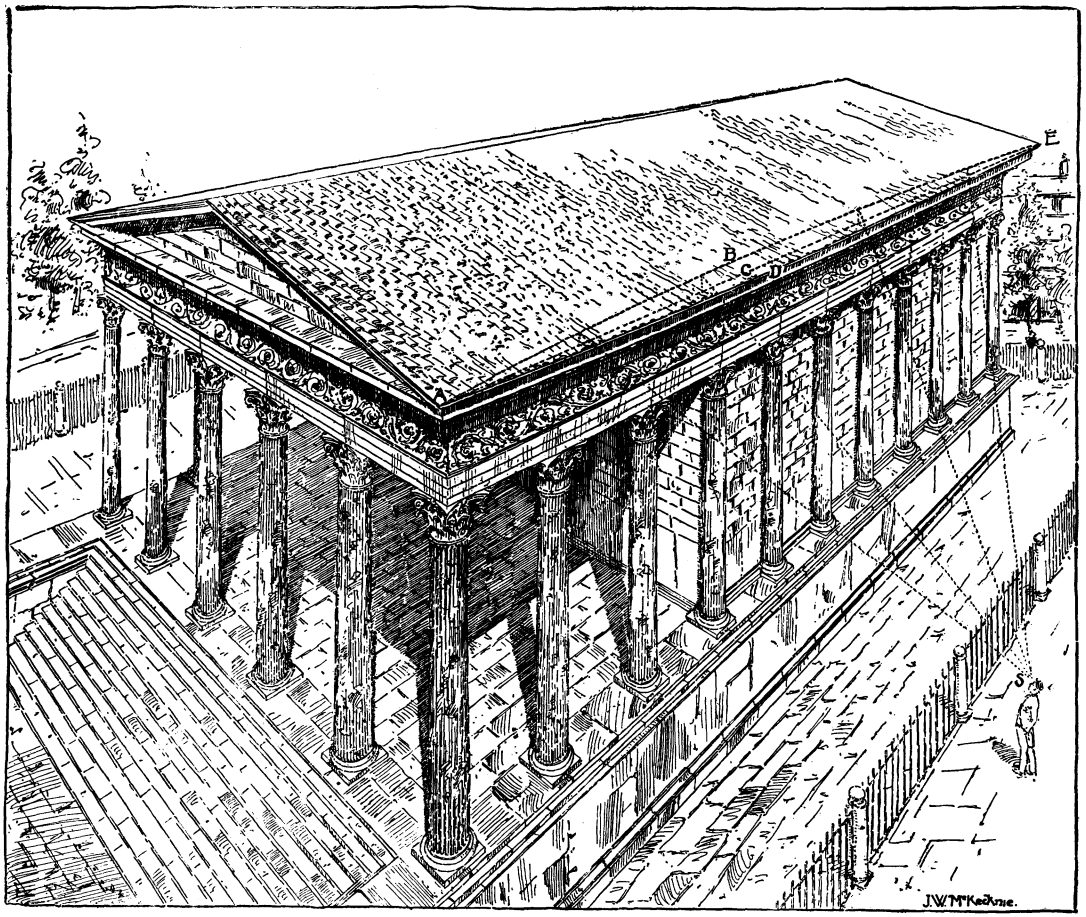
struction, like that at Medinet Habou and Edfou. At least that is my suggestion. The great court at Karnak was still so filled with rubbish in 1891 that one could ascend to the line of the architraves on both portico sides of the court. By sighting along the line of these architraves I verified the existence of very pronounced curves of several inches, convex to the centre of the court. I think that these curves may be owing, to some extent, to masonry displacement, but that this displacement has been a movement toward the centre of the court, owing to an original lean of the columns and original curve of the architraves in this direction. At Medinet Habou the portico roofs of the second court are in fine preservation, and there has not been the slightest parting of joints or displacement of masonry which could suggest an accidental cause for the curves.

We will notice finally, once more, that the effect of such convex curves in the upper line of a building is to increase the appearance of dimension to an extraordinary degree on near approach; that a convex curve is equal in effect, at an angle of forty-five degrees, to a curve of the same deflection in elevation; and that two writers, viz., Hoffer and Boutmy, have attributed the Greek curves in elevation to a purpose of perspective illusion.

All these various facts may be considered as helpful to an understanding of the curves of the *Maison Carrée* and of the temple of Poseidon at Pæstum.

I published an article in Scribner's Magazine for August 1874, entitled "A Lost Art," in which the purpose of optical illusion was ascribed to certain curves in masonry of the cathedral and other churches at Pisa. The announcement that deceptive perspective schemes in the arrangement of arches, pier spacings, and walls, is a widespread phenomenon in Mediæval cathedrals is probably original with me and I shall soon publish a work on this subject. The more widespread in time and place the use of optical refinements in architecture appears to have been, the greater probability attaches to each new instance of demonstrated intentional construction in which such an effect was obtained, that the effect obtained was intentional.

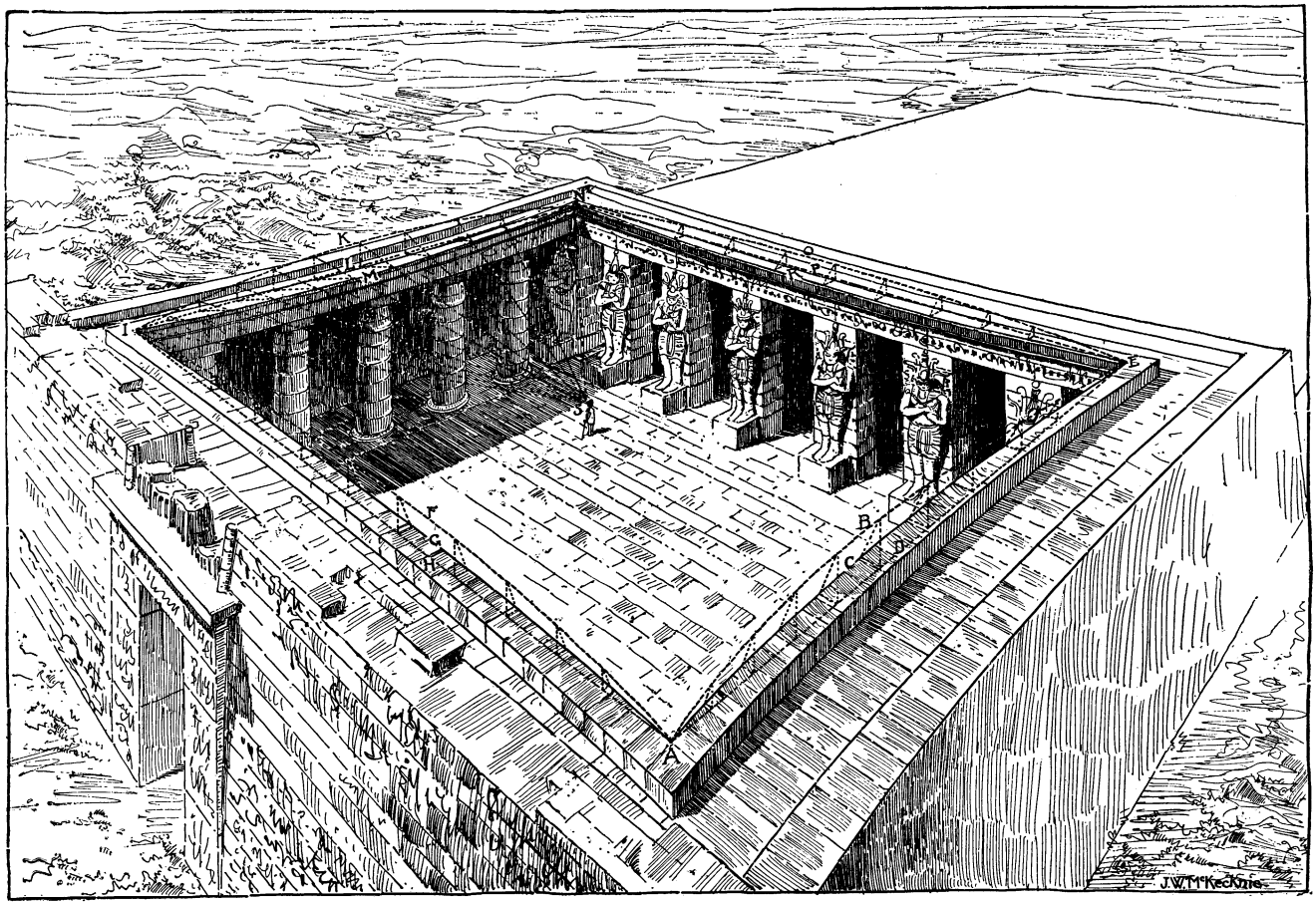
New York City. WM. HENRY GOODYEAR.
February, 1895.



BIRD'S-EYE VIEW OF THE MAISON CARRÉE AT NIMES.

DRAWN BY J. W. MCKECKNIE.

(Straight dotted lines show deflection of cornice: curved dotted line shows optical effect of cornice curve.)



BIRD'S-EYE VIEW OF THE INNER TEMPLE COURT AT MEDINET-HABOU.

DRAWN BY J. W. MCKECKNIE.

(Straight dotted lines show curved deflections of cornices: curved dotted lines show optical effect of cornice curves from different points of view.)